Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

The two-dimensional mode of the variable-density Kelvin-Helmholtz billow L. JOLY, J. FONTANE, ENSICA/DMF, Toulouse, France, J.-N. REINAUD, Univ. of St. Andrews, UK — We perform a three-dimensional stability analysis of the Kelvin-Helmholtz billow, developing in a shear-layer between two fluids with a density ratio of 3. We begin with 2D-simulations of the temporally evolving mixing-layer yielding the unsteady base flow fields. The Reynolds number is 1500 while the Schmidt and Froude numbers are infinite. Then exponentially unstable modes are extracted from a linear stability analysis. We retain modes growing faster than the primary wave according to a quasi-steady approach. The spectrum is analyzed and shown to exhibit a typical two-dimensional mode, in addition to core-centered and braid-centered ones. This particular mode develops on the baroclinically-enhanced vorticity ridge lying on the light side of the KH-billow. The wavelength of the 2D-instability is ten times shorter than the one of the primary wave. Its amplification rate competes well against the one of the least-stable 3D-modes. The non-linear continuation of this mode is computed from two starting points during the roll-up of the primary wave. We describe secondary roll-ups due to a small-scale Kelvin-Helmholtz mechanism favored by the underlying strain field. This mode is demonstrated consistent with finite Reynolds number mixing-layers. We are also able to discuss its precedence against transverse modes thus contributing to the complex picture of the transition of the variable-density shear-layer.

Laurent Joly
ENSICA Département de Mécanique des Fluides, 31056 Toulouse

Date submitted: 16 Jul 2007 Electronic form version 1.4